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(19)

(54) IMPROVEMENTS RELATING TO DOCUMENT SORTING MACHINES

(71) We, MASSON SCOTT THRISSELL ENGINEERING LIMITED, of Thrissell Works, Easton Road, Bristol, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to machines for sorting documents or other articles such as mail envelopes, or the like.

The invention is concerned particularly but not exclusively with sorting machines of the type comprising an input or identifying unit where the articles (hereinafter referred to for convenience as envelopes) are inspected visually or by machine, and decoder, or otherwise identified as to their sorting addresses, and a sorting unit in which the envelopes are carried by a conveyor system past a number of diverters which are operated automatically and selectively by the input unit to divert selected envelopes to sorting stations or positions.

Existing machines of this type commonly comprise endless belt-type conveyors, sometimes combined with roller conveyors, arranged to convey the envelopes either individually or in presorted boxes or containers over preselected paths so as to pass a succession of solenoid operated diverter gates which are actuated at the appropriate time instants properly related to the travel and speed of the envelopes, so that a selected diverter gate will open at the correct instant when the respective envelope is about to reach that gate. Such machines suffer from inaccurate timing errors caused by stretch of the belts, which may run the whole length of the machine, so that the cumulative error at the far end of a belt can be quite appreciable. Moreover with conventional belt conveyors the envelopes are not positively located in relation to the belt, and therefore it is necessary to have greater "pitch" or interval between letters to offset the inaccuracy of the positional control. Moreover the "slip", or relative movement or positional error of the envelopes can only be compensated by increasing the pitch or distance between envelopes, which in turn increase the necessary transport speed for any given sorting rate per hour.

Other types of conveyors sometimes used with sorting machines of this general type consist of a series of pairs of rollers arranged to "nip" and drive the envelopes from one to the next, with one roller of each pair driver by suitable gearing, belt or chain drives, or otherwise. Driven roller conveyors of this type suffer from many of the disadvantages of belt conveyors and in addition they are noisy and involve considerable friction owing to the large numbers of rollers and bearings, the letters are not positively and accurately driven and located, lubrication presents a problem, and the drive means between the rollers may produce the equivalent of "stretch" or lag, resulting in further positional errors.

Accordingly it is one object of the invention to provide an improved sorting machine with a conveying system which will eliminate or at least reduce some of the problems and disadvantages of existing methods.

Broadly stated the invention consists in a sorting machine for articles of mail, documents, or the like, including a number of pre-fabricated modulator sorting units each including a number of sorting positions at different levels, conveyors for moving the articles through the respective unit at each level, and deflector gates for deflecting articles into selected positions, the modulator units being designed and arranged to be coupled together to form the complete sorting machine, and in which each conveyor includes an endless belt or flexible conveyor member formed with regularly spaced teeth acting as driving and indexing elements, and provided with further regularly spaced carrier members for engaging and conveying the articles to be sorted at accurately determined intervals, and each conveyor in one modular

unit is coupled to and synchronised with a conveyor in the next modular unit by means of a synchronising drive.

It is a further, subsidiary, object of the invention to provide an improved conveying system for a document sorting machine, which will handle and present the envelopes or documents in such a way that some of the disadvantages of existing systems are avoided. Thus in one existing type of document handling machine the documents are conveyed along the length of a conveyor lying flat on the conveyor belt or track and with their longer lengths parallel with the direction of movement. To obtain any substantial performance in terms of documents per hour the linear speed of the documents must be very great in such a system. This introduces problems in accurately locating and positioning the envelopes, introducing them correctly into the conveyor, and operating the diverter gates. Moreover for any practical machine the dimensions tend to be increased undesirably.

In another existing type of machine the documents or envelopes are conveyed individually or in groups lying in planes perpendicular to the direction of movement of the conveyor. For example the envelopes may be in vertical attitudes on a horizontal moving conveyor and extending across the width of the conveyor belt. In such systems the linear speed of travel can be considerably reduced for any given sorting rate but problems arise in introducing and removing envelopes when closely "stacked" in such a system.

According to a preferred feature of the invention the conveyors are arranged to transport the articles lying flat in planes parallel with the plane of the conveyor and with the major dimension of the article extending transversely across the conveyor.

In a preferred construction the carrier members are formed with spaced fingers, loops, or other pusher members, to engage an edge of an article to be sorted, and to fit partly into or between a cooperating ridged or grooved surface or group of rails for supporting the article.

The invention may be performed in various ways and one particular embodiment, with some possible modifications, will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic side elevation illustrating the main components of a letter sorting machine to which the invention may be applied,

Figure 2 is a diagrammatic plan view on an enlarged scale showing a series of conveyor belt sections of the machine of Figure 1, arranged end-to-end to form an extended conveyor,

Figure 3 is a side elevation on a somewhat enlarged scale showing in more detail the construction of the transfer device for moving documents between adjacent conveyor sections,

Figure 4 is a diagrammatic end view on an enlarged scale, and partly in section, showing a portion of one of the "comb" type pushers carried by the conveyor belts,

Figure 5 is a diagrammatic side elevation illustrating a fault detection system incorporated in the conveyor, and

Figure 6 is a diagrammatic view, corresponding to part of Figure 5, on a further enlarged scale, the operation of the detection system of Figure 5.

Referring first to Figure 1 the machine consists essentially of an input section 9 combined with a conveying and sorting section consisting of a series of sorting modules. In this illustrated example there are only two modules 10 and 11, but any desired number may be provided, and further modules can be added without difficulty to an existing system. The input section 9 may be of generally conventional design and construction, and may include an automatic "letter facing" unit (not shown) followed by a manual or automatic coder or decoder 16. In a manual system the envelopes are presented in succession before an operator at a key board who types appropriate code symbols onto the envelope, in a form in which they can subsequently be "read" by an automatic reader such as 16. In the alternative automatic system as illustrated the envelopes carry preprinted code symbols and are fed by a stepping conveyor 15 direct to the automatic reader 16. From the "reader" 16 the envelopes are automatically fed in succession into a belt conveyor 8 which transfers them to a vertical conveyor 19, from which they are selectively diverted by solenoid-operated diverter gates 18 into any selected one of (say) 4 levels. At each level a further conveyor system 13 is arranged to convey the envelopes horizontally away from the starting point, and in doing so the letters pass a series of diverter gates 14 which control the selective delivery of letters into the individual sorting boxes 12. The gates 14 and 18 are controlled in known manner by the automatic reader 16. The conveyor systems 13 are of the positive-positional type, with positive carrier members at fixed intervals along the conveyors. The conveyor 8, particularly if of any great length, may also be of the positive-positional type.

In normal existing sorting machines of this general type the conveyor belts extend horizontally the full length of the machine and are liable to a considerable degree of "stretch" which can cause inaccuracies in the speed and location of envelopes and consequent incorrect sorting.

In this example of the invention the problem of "stretch" in the horizontal conveyor belts 13 is avoided by building up these con-

veyors from a number of shorter sections, as illustrated more clearly in Figures 2 and 3. Each conveyor section 13 extends for the length of one of the modules 10, 11, etc., and each comprises a pair of parallel flexible belts 20, 21, formed with teeth 22 on one side to permit the belt to be driven and accurately indexed relative to a toothed driving sprocket 23 at one end. The sprocket 24 at the other end is not driven, but the sprocket bearing is resiliently sprung away from the first sprocket to hold the belts 20, 21, taut. The other (external) surface of each belt is provided with a series of spaced pusher elements (indicated at 25 in Figure 3) to engage and transport the individual envelopes, and details of one preferred pusher element are described in more detail below with reference to Figure 4.

As shown in Figure 2 the driving sprocket 23 of each belt section 13 is driven through a multiple driving chain system comprising a series of chain loops 26, positively interconnecting the shafts of the sprockets 23, so that all rotate in synchronism. Alternatively the sprockets 23 may be driven through a suitable gearing from a continuous longitudinal driving shaft, preferably so designed and arranged that there is little if any lag or stretch between one end of the machine and the other. As a result if there should be any slight stretch in an individual belt length the out-of-phase error will be corrected or restored at the next belt section so that the overall or cumulative error is accordingly reduced, particularly at the last section.

Figure 3 illustrates the preferred system for transferring documents between different modules 10, 11, etc., and designed to maintain the accurate timing or positioning of the letters as they proceed from one module to the next. Each letter is slightly accelerated at the moment of transfer to avoid any undesirable interaction between the edges of the letter and the adjacent pusher elements 25 on the adjacent sections of conveyor belt.

For this purpose the shaft of the sprockets 24 on the "downstream" side of the module junction has three drums 30 symmetrically spaced across the width of the conveyor. The diameter of each drum 30 is such that its peripheral speed is slightly greater than the conveyor speed, and each drum is provided at one part of its surface with a recess (not illustrated) to allow the pushing elements 25 to pass freely around the drive pulley or sprocket. Vertically below each drum is a pressure roll 31 resiliently sprung upwards and cooperating with a pre-set stop to provied a minimal gap slightly less than the normal thickness of a letter. Thus three driving "nips" are formed between the drums 30 and rolls 31, capable of driving the letter 33 through the transfer stage even without the assistance of one of the pusher elements 25. The pre-set roller gap or "nip" assists in obtaining a positive pick-up and prevents the pressure rolls 31 from entering the slots in the drums. At the point of transfer the normal drive to the letter is lost, but the acceleration of the letter also serves the useful purpose of advancing the letter during this instant.

After the letter has been ejected from the "nip" into the next conveyor section (i.e. to the left in Figure 3) it is slowed down by friction until the following pusher bar 25 regains control immediately after, and accurate timing is completely restored. A projecting platform or rail from one module lines up with the bed or static conveyor platform of the adjacent module so that the letters can travel horizontally without interruption from one module to the next.

The preferred pusher bar system is illustrated in Figure 4. The moving conveyor belt cooperates with a static supporting system or "dead plate" 40 formed with a number of longitudinally extending spaced ribs or rails 41, interrupted as necessary along the length of the machine to permit the letters 33 to be diverted downwards into the sorting boxes or cassettes 12 by the diverter gates 14 which are positioned in line with these rails 41 across the width of the conveyor. Cooperating with the rails 41 of the dead plate 40 are a series of elongated spaced top guides or rails 43 carried by overhead supports 44 and providing sufficient clearance from the dead plate for the individual letters 33 and pusher bars 25 to travel along the length of each module 10, 11, as necessary.

Each pusher bar 25 is an undulating metal rod, pivotally mounted at each end in a support pad or bearing 47 carried by one of the two operating belts 20, 21 of the conveyor, one on each side. The pusher rods 25 are spaced apart along the length of the belt at predetermined intervals, related to the standard size of the envelopes and to the intervals of the teeth 22 on the belt. In the example illustrated in Figure 4 the undulating rod 25 has lower depending loops 48 which lie respectively between one of the top guides 43 and the dead plate 40 and intervening upward loops 49 which provide gaps or clearances where the tips of the diverter gates are raised above the level of the envelopes. Each diverter gate 14 may for example comprise five parallel fingers 50 arranged to rock together about a horizontal axis, and spaced across the width of the conveyor to engage across the whole length of the edge of an envelope. The undulating pusher bar 25 has a corresponding number of loops 49 to accommodate these diverter fingers.

In this particular system the letters are arranged to be conveyed individually, each lying horizontally flat on the conveying sur-

face with its larger dimension or length across the conveyor. This has several advantages compared with more normal systems in which the letters are conveyed in other attitudes. If the individual letters lie horizontally flat on the conveyor surface with their larger length parallel to the direction of movement the speed of the conveyor must be increased to achieve any specific sorting rate or the sorting rate must be reduced. Also the overall length of the machine must be undesirably increased. If alternatively the letters are conveyed in vertical attitudes, i.e. in parallel vertical planes, the dimensions and speed of the conveyor can be reduced for any specific sorting rate, but other problems arise in transporting and diverting envelopes to and from the conveyor.

Each undulating bar 25 is torsionally sprung in its pivot mounting, against a limit stop, such that its normal position is in a generally vertical plane as shown in Figure 4. In the event of a fault or jam in the conveyor, the increased resistance to the movement of the bar 25 will cause it to rotate in its bearing pads 47, and so cause pivotal movement of a metal blade 52 attached to the end of each bar 25. The blades 52 act as optical "shutters" or interposers in an optical fault detection system illustrated in Figures 5 and 6.

When any of the pusher bars 25 is rotated the interposer blade 52 moves downwards as indicated at 54 in Figure 5, into the path of an optical beam 55 projected horizontally below and to one side of the dead plate 40 by a light projector 57. The beam is directed along the length of the conveyor to a photocell optical receiver 58 at the other end, and it will be seen that if any one of a number of interposer blades 52 moves downwards to intercept the light beam the system will indicate a failure. The optical receiver 58 is connected to suitable electric circuitry for providing a visible or audible warning and for immediately interrupting the drive to the conveyor.

Figure 6 illustrates geometrically the movement of the interposer blades 52 as they pass around the right-hand end sprockets 24 of one of the conveyor sections, and this illustrates the factors governing the choice of various dimensions and relationships such as the vertical position of the optical beam. It will be noted that although each of the interposer blades 52 may remain in its normal undeflected attitude throughout its movement, during the lower part of its rotational movement at the extremity of the conveyor section, the locus or path 60 of the extreme tip 61 of the blade will drop to a level 63 appreciably below the normal level 62 of the blade during the horizontal run. In this angular travel the interposer blade 52 will interfere with any optical beam positioned within the vertical range D in Figure 6. For the optical system to operate as a detection unit therefore it is necessary to ensure that any rotation of a pusher bar 25, which requires a fault detection output signal, will move the prospective interposer blade 52 below this vertical range D into the region *t* where the beam 55 is located. This can be achieved either by slightly increasing the length of the interposer blade or by increasing the operating angle θ through which the blade will rotate. Unfortunately increase in the interposed blade length gives an increased radius of the locus of the blade tip 61 and so further increases the interference sector, so that the position of the optical beam must be lowered even further. In fact it can be shown that there is an optimum length for the interposer blade to give the minimum operating angle θ, which can be calculated mathematically.

The sensitivity of the system is preferably high enough to allow detection of a thin letter trapped beneath a pusher bar as shown at 65 in the right hand part of Figure 5. A particular advantage of the system is that maximum sensitivity occurs at the point of maximum interference as shown at 66 in Figure 6. It is at this point where faults, if any, are most likely to occur, as a mistimed letter entering the conveyor would deflect the pusher bar 25 at approximately this point. Therefore the quickest and most effective response is obtained at this more critical part of the machine cycle.

In a possible alternative system means may be provided for inhibiting or otherwise rendering inoperative the optical detection system 57, 58, during the interference period of each of the interposer blades 52. This can be achieved electrically by applying suitable electronic gating logic to the electrical output circuit associated with the optical receiver.

Reference is drawn to Specification No. 1,374,092 (Application No. 15180/71) which illustrates the same sorting machine and claims features for detecting faulty operation thereof.

WHAT WE CLAIM IS:—

1. A sorting machine for articles of mail, documents, or the like, including a number of pre-fabricated modular sorting units each including a number of sorting positions at different levels, conveyors for moving the articles through the respective unit at each level, and deflector gates for deflecting articles into selected positions, the modular units being designed and arranged to be coupled together to form the complete sorting machine and in which each conveyor includes an endless belt or flexible conveyor member formed with regularly spaced teeth acting as driving and indexing elements, and pro-

vided with further regularly spaced carrier members for engaging and conveying the articles to be sorted at accurately determined intervals, and each conveyor in one modular unit is coupled to and synchronised with a conveyor in the next modular unit by means of a synchronising device.

2. A sorting machine according to claim 1, in which the carrier members are formed with spaced fingers, loops or other pusher members, to engage an edge of an article to be sorted, and to fit partly into or between cooperating ridges on a member arranged to support the article.

3. A sorting machine according to claim 1 or claim 2, in which the conveyors are arranged to transport the article lying flat, in planes parallel with the plane of the respective conveyor, and with the major dimension of each article extending transversely across the conveyor.

4. A sorting machine according to any of the preceding claims, including a fault detection system, including an optical projector projecting a beam parallel to the conveyor path, and an optical shutter attached to each pusher on the endless conveyor, so that movement of the pusher caused by an obstruction interferes with the light beam.

5. A sorting machine according to any of the preceding claims, including means for temporarily accelerating each article at the instant of transfer from one modular unit to the next.

6. Document sorting apparatus substantially as described with reference to the accompanying drawings.

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1374091 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

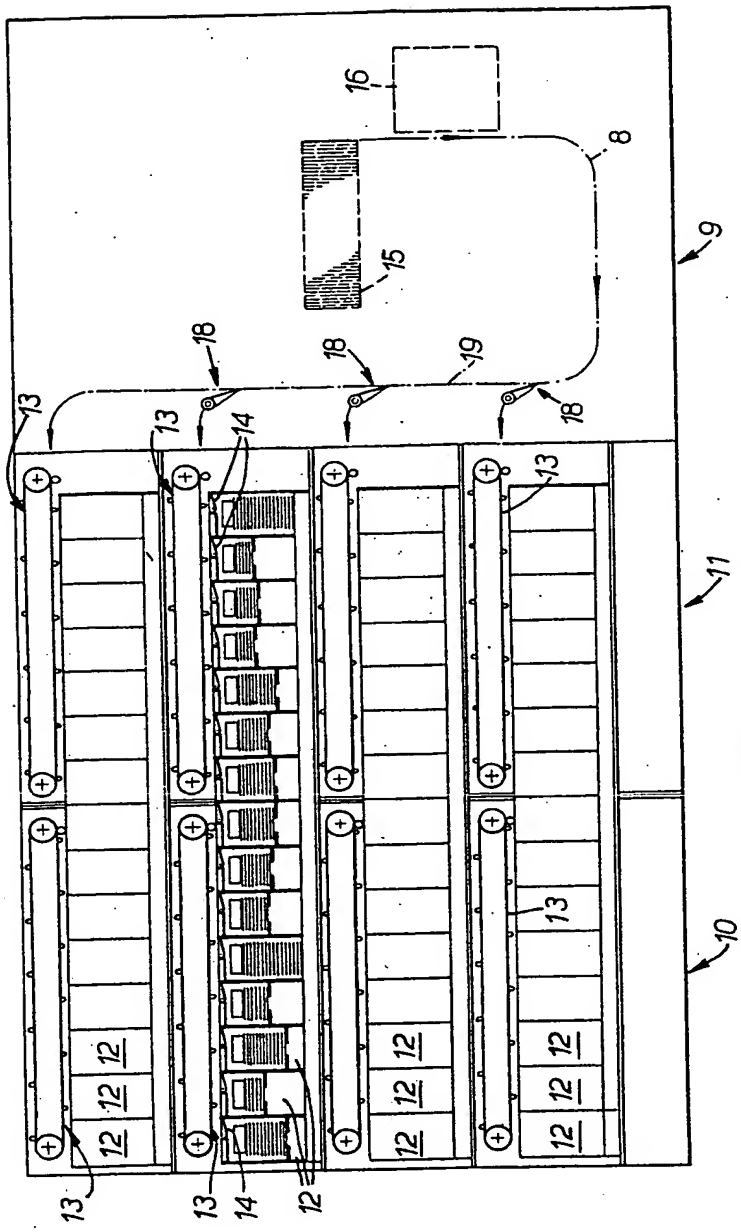


FIG. 1.

1374091 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

FIG. 2.

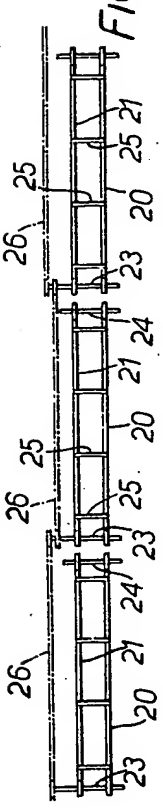


FIG. 3.

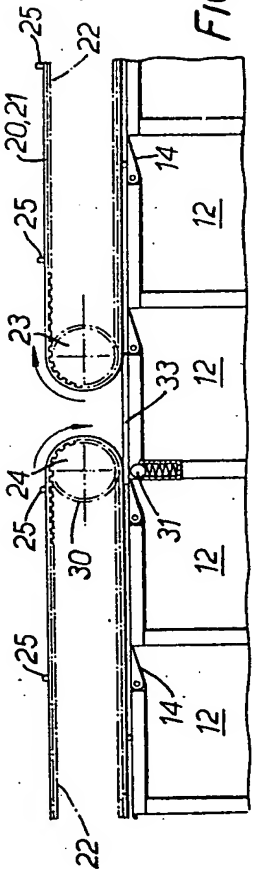
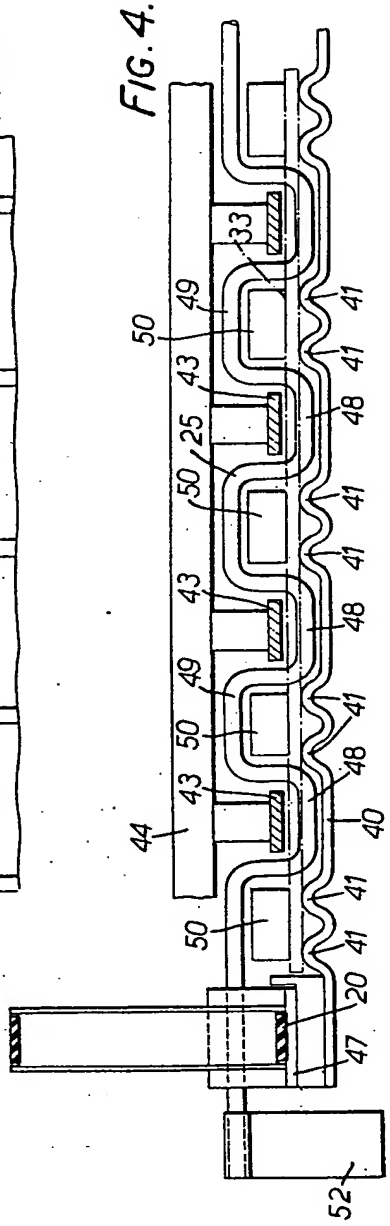


FIG. 4.



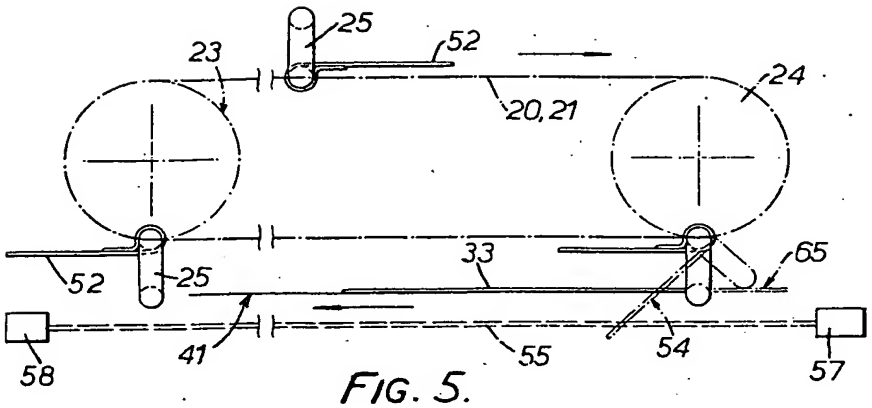

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FIG. 5.

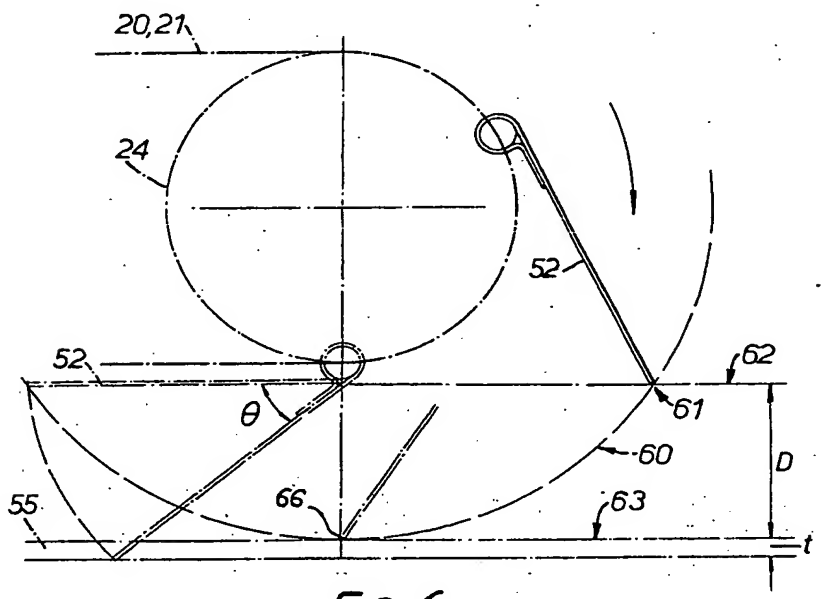
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FIG. 6.